REMARKS

The above amendments to the specification, claims, and abstract have been made to place the application in proper U.S. format and to conform with proper grammatical and idiomatic English. None of the amendments herein are made for reasons related to patentability. No new matter has been added.

Attached hereto is a marked-up version of the changes made to the specification and claims by the current amendment. The attached page is captioned "**Version with markings to show changes made**".

In the unlikely event that the transmittal letter is separated from this document and the Patent Office determines that an extension and/or other relief is required, applicant petitions for any required relief including extensions of time and authorizes the Commissioner to charge the cost of such petitions and/or other fees due in connection with the filing of this document to **Deposit Account No. 03-1952** referencing docket no. 449122021000. However, the Commissioner is not authorized to charge the cost of the issue fee to the Deposit Account.

Respectfully submitted,

Dated: February 19, 2002

Kevin R. Spivak
Registration No. 43,148

Morrison & Foerster LLP
2000 Pennsylvania Avenue, N.W.
Washington, D.C. 20006-1888
Telephone: (202) 887-6924
Facsimile: (202) 263-8396

VERSION WITH MARKINGS TO SHOW CHANGES MADE

For the convenience of the Examiner, the changes made are shown below with deleted text in strikethrough and added text in underline.

In the Specification:

Page 1, before the first paragraph, please delete the following:

~~Description~~

Page 1, before the first paragraph, please change the Title as follows:

CIRCUIT AND METHOD FOR DETERMINING ~~THE~~ AN OFFSET ERROR OF A MEASUREMENT ~~THAT IS SUBJECT TO SUCH~~ SUBJECT TO AN OFFSET ERROR OF ~~THE~~ A COIL CURRENT OF AN ELECTROMAGNETIC ACTUATOR

Page 1, between lines 6 and 7, please insert the following headings and paragraph:

CLAIM FOR PRIORITY

This application claims priority to International Application No. PCT/DE00/02691 which was published in the German language on August 10, 2000.

TECHNICAL FIELD OF THE INVENTION

Please replace the paragraph beginning line 7 of page 1 with the following rewritten paragraph:

The invention relates to a circuit and ~~a~~ method for determining the offset error of a measurement, and in particular, determining the offset error of a measurement that is subject to ~~such~~ an offset error of ~~the~~ a coil current of an electromagnetic actuator.

Page 1, between lines 11 and 12, please insert the following heading:

BACKGROUND OF THE INVENTION

Please replace the consecutive paragraphs beginning at line 12 of page 1 with the following rewritten paragraphs:

Electromagnetic actuators, which for example drive a gas exchange valve of an internal combustion engine, usually have at least one coil. An electromagnetic actuator for gas exchange valves is known, for example, from DE 297 12 502 U1 or EP 0 724 067 A1. It has a rest position, which lies between a closed position and an open position and from which it can be deflected by means of electromagnets.

To open or close a gas exchange valve driven by ~~this~~ the actuator, the coil assigned to the respective final position is supplied with current, the required current being greater in the capture phase than in the holding phase, in which the gas exchange valve is held in the final position of the actuator.

If the corresponding electromagnet is ~~in this case simply~~ provided with current, the valve disk of the gas exchange valve hits the valve seat at high speed, which produces noise and is conducive to wear. To avoid this, the striking speed must be reduced. For this purpose, the current supply is suitably controlled.

For this purpose, ~~it is necessary in the case of electromagnetic actuators to measure~~ the coil current of the electromagnetic actuators is measured. This can take place, for example, by potential taps at a resistor connected in series with the coil. ~~By means of~~ According to Ohm's law, the current can be calculated from the value of the resistance and the measured voltage drop.

The voltage drop is usually sensed with an analog circuit. In ~~the case of~~ such an analog circuit, an offset error is unavoidable, i.e. the measured voltage is too great or too small. A measuring device which performs an automatic offset voltage compensation is known from DE 34 29 854 A1, but a special hybrid module is required for it, which is relatively expensive. A similarly acting circuit arrangement is known from DE 34 48 182 C2. In this case, a memory module is used for the offset compensation.

Page 2, between lines 14 and 15, please insert the following headings and paragraphs:

SUMMARY OF THE INVENTION

In one embodiment of the invention, there is a method for determining the offset error of a measurement, where the measurement is subject to such an offset error of a coil current of an electromagnetic actuator, comprising measuring the coil current through a corresponding coil

when the actuator is in a final position in which the coil is not supplied with current during the operation of the actuator, and providing the value obtained as the offset error.

In another aspect of the invention, the coil current is measured by potential tapping before and after a resistor connected in series with the coil, wherein the potential taps are being fed to a differential amplifier, and a constant value is added to a value output by the differential amplifier.

In another aspect of the invention, the actuator has two coils respectively assigned to the final position, and the coil current through the coil not assigned to the present final position is measured to determine the offset error.

In yet another aspect of the invention, the method includes supplying the coil assigned to the final position with a capture current and a holding current such that the actuator is transferred into the final position.

In another embodiment of the invention, there is a circuit for determining the offset error of a measurement, the measurement subject to an offset error of a coil current I of an electromagnetic actuator, the circuit comprising at least one coil with a resistor connected in series into a supply line of the coil, a differential amplifier to which the potential on both sides of the resistor is fed, and a control circuit which evaluates the output of the differential amplifier when the coil is not carrying any current during the operation of the actuator, and the value obtained is output as the offset error I_o.

In another aspect of the invention, wherein the output of the differential amplifier is fed together with the output of a constant-voltage source to an adding element such that an offset error of a specific polarity is obtained.

In another aspect of the invention, the actuator has first and second coils assigned to a final position, and a resistor is connected in the supply line to each coil, the differential amplifier taps the voltage dropping across the resistor, and the control circuit evaluates outputs of the differential amplifiers.

In still another aspect of the invention, the control circuit for supplying current to the first and second coils transfers the actuator into a final position, and the first coil assigned to the final position carries a capture current and a holding current, and the control circuit evaluates the output of the differential amplifier of the second coil.

In another aspect of the invention, the offset error I_o is determined and low-pass-filtered multiple times.

BRIEF DESCRIPTION OF THE DRAWINGS

An exemplary embodiment of the invention is explained in more detail below with reference to the drawings, in which:

Figure 1 shows a section through an actuator for a gas exchange valve of an internal combustion engine.

Figure 2 shows the time series of the current flow through the two coils of Figure 1.

Figure 3 shows a circuit for sensing the coil current through a coil.

Figure 4 shows the states passed through during the operation of the gas exchange valve in a flow diagram.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

Please replace the paragraph beginning line 15 of page 2 with the following rewritten paragraph:

The invention ~~is based on the object of providing a~~ relates to a circuit of an electromagnetic actuator and a method for determining the offset error of a measurement that is subject to such an offset error of the coil current of an electromagnetic actuator, with the result that no special modules are required.

Please delete the paragraph beginning at line 22 of page 2 in its entirety.

Please replace the consecutive paragraphs beginning at line 25 of page 2 with the following rewritten paragraphs:

~~The invention is based on the realization that~~ In the invention, there is a final position of the actuator in which a coil is not supplied with current. If the coil current is measured at this point in time, the offset error can be determined ~~from this~~.

In the case of an actuator which is used, for example, for driving a gas exchange valve and ~~in the case of which,~~ for opening or closing the gas exchange valve, the coil assigned to the corresponding final position is firstly supplied with a capture current ~~and then with~~. Then, a

holding current is supplied, and the determination of the offset error is preferably performed on that coil which is assigned to the other final position when the coil supplied with current is in the holding phase. This is because, at this point in time, ~~it is ensured that~~ the coil of the circuit for which the offset error is being determined is not supplied with current. In the capture phase, on the other hand, ~~this is not ensured, since for example the current from its previous holding phase can still decay or, under certain circumstances,~~ the coil is still briefly supplied with current during the capture phase for the delayed transfer of the actuator into the other final position. Since, for example, the current from its previous holding phase can still decay.

Please delete the paragraph beginning at line 12 of page 3 in its entirety.
Please delete the paragraph beginning at line 15 of page 3 and ending at line 31 of page 3 in its entirety.

Please replace the paragraph beginning line 33 of page 3 with the following rewritten paragraph:

Figure 1 shows an electromagnetic actuator 1 for a gas exchange valve ~~which is designed as~~. The actuator 1 is shaped, for example, as which is designed as a disk valve and comprises a valve disk 2 with a valve seat 3 and a valve stem 4, which is mounted in a guide 5 on the housing side and is provided at the upper end with a conical piece 6. The valve disk is moved by the actuator 1 between two final positions: in an upper final position, the gas exchange valve is closed and in a lower final position it is open.

Please replace the paragraph beginning line 11 of page 5 with the following rewritten paragraph:

In ~~f~~Figure 2, the current I through the coil 14 or 16 is plotted over time t. In this case, the current I through the coil 14 is represented by a solid line, the current through the coil 16 is represented by a dashed line. This current flow is set by the control circuit 28, in order with the aid of a capture current circuit to switch the valve over into the other final position, respectively, reliably and without bouncing. For this purpose, the holding current Hs, Ho holding the armature 18 in the respective final position is switched off, so that the armature is set in motion in the direction of the other final position by the relevant, relaxing spring. At the same time, the corresponding winding 14 or 18 is supplied with the capture current Fo, Fs. For closing the valve, the coil 14 is supplied with the capture current Fs. If the armature 18 is resting on the end

face 19, the coil 14 is then ~~only~~ supplied with lower holding current Hs, which is sufficient to hold the armature 18, and consequently the gas exchange valve, in the closed position.

Please replace the consecutive paragraphs beginning at line 7 of page 6 with the following rewritten paragraphs:

~~In other words, t~~The gas exchange valve passes through the states I to IV represented in ~~f~~Figure 4. In state I, the valve is closed and the holding current Hs is flowing in the coil 14. Next, in state II, the valve is opened, for which purpose the coil 16 is supplied with the capture current Fo, and the holding current Hs in the coil 14 slowly decays. Once the armature 18 has come up against the end face 20, the supply of current to the coil 16 is switched over to the holding current Ho and the valve is open (state III of figure 4). For closing, the coil 14 is in turn provided with capture current, which is represented in figure 4 as state IV. Once the armature 18 has come up against the end face 19, state I exists again.

In order then to be able to use the current through the coil 14, 16 in the control circuit 28, a measurement of the coil current is necessary. ~~The~~ A driver circuit ~~required~~ used for this purpose is represented, together with a more accurate representation of the control circuit 28, by way of example in ~~f~~Figure 3. Figure 3 shows the driver circuit 26 for the coil 14. The driver circuit 27 is designed in an analogous way.

As ~~can be seen~~ shown in ~~f~~Figure 3, the coil 14 is activated by an asymmetric half-bridge. In this case, the coil 14 is connected between a highside FET Th, which on the other hand is connected to the supply voltage Vcc, and a lowside FET Tl, which in turn is connected ~~on the other hand~~ via a resistor R to the reference potential. Connected in the forward direction between the reference potential and the connecting nodes of the coil 14 to the highside FET Th is a diode D2. Connected in the forward direction between the connecting nodes of the coil 14 to the lowside FET Tl and the supply voltage Vcc is a diode D1. Finally, the supply voltage Vcc is connected to the reference potential via a capacitor C. Between the lowside FET Tl and the reference potential there lies a resistor R.

Please replace the consecutive paragraphs beginning at line 21 of page 7 with the following rewritten paragraphs:

If the desired current is zero, the highside and lowside FETs Th, Tl are turned off. In this state, no current flows through the resistor R and the voltage at the input of the differential amplifier 30 is zero. On account of the internal construction of the differential amplifier 30, it is possible however for a negative voltage to be present at the output as the result of an offset error. In the case of a measuring chain of a unipolar construction, as usually used in automotive electrical engineering, however, a negative measuring voltage is undesired. For this reason, an artificially generated offset is added on at the adding node 31. For this purpose, the output of a constant-voltage source 32 is additionally fed to the adding node 31. Consequently, there is a positive voltage present at the input of the filter 33.

For determining the offset error, ~~it must be ensured that~~ the resistor R ~~is~~ must not be flowed through by a current. This ~~can only be ensured~~ is accomplished for the coil 14 in the holding phase of the other coil 16, since this is the ~~concerns a~~ final position in which the coil 14 for the circuit 26 of which the offset error is to be determined is not supplied with current. After determination of the offset error I_o of the non-activated coil, the actual current I_m can be corrected as follows when the coil is next activated in the then-following cycle: $I_{corr} = I_m - I_o$

Please replace the consecutive paragraphs beginning at line 19 of page 8 with the following rewritten paragraphs:

This weighted average value is one possible form of low-pass filter; others are conceivable as readily understood by the skilled artisan. In this case, $I_{o,i}$ is the ith measurement of the offset error, I_m is the actual value of the current(raw value of the analog/digital converter 34) and k is a weighting factor.

~~This~~ The low-pass filtering takes account of the realization that the offset error I_o fluctuates in a temperature-dependent manner and changes ~~only~~ slowly with respect to the sampling rate with which the offset error is determined.

In the Claims:

~~Patent claims~~

What is claimed is:

1. (Amended) A method for determining the offset error of a measurement ~~that~~, where the measurement is subject to such an offset error of ~~the~~ a coil current of an electromagnetic actuator~~(1), in which method~~
, comprising:

~~the measurement that is subject to the offset error of~~ measuring the coil current through a ~~coil (14, 16) is performed~~ corresponding coil when the actuator ~~(1)~~ is in a final position in which the coil ~~(14, 16)~~ is not supplied with current during the operation of the actuator~~(1),~~; and

providing the value obtained ~~is taken~~ as the offset error.

2. (Amended) The method as claimed in claim 1, ~~characterized in that~~ wherein the coil current is measured by potential tapping before and after a resistor connected in series with the coil~~(14, 16),~~ wherein

the potential taps are being fed to a differential amplifier~~(30)~~, and a constant value ~~being~~ is added to ~~the~~ a value output ~~value of~~ by the differential amplifier~~(30) in order always to obtain an offset error signal of a specific polarity.~~.

3. (Amended) The method as claimed in ~~one of the preceding claims, characterized in that, in the case of an actuator (1) with two coils (14, 16)~~ claim 1, wherein the actuator has two coils respectively assigned to ~~a~~ the final position, and

the coil current through ~~that~~ the coil ~~(14, 16) which is~~ not assigned to the present final position is measured ~~for determining~~ to determine the offset error.

4. (Amended) The method as claimed in claim 3, ~~characterized in that, for transferring the actuator (1) into a final position, the coil (14, 16) assigned to this final position is firstly supplied~~ further comprising:

supplying the coil assigned to the final position with a capture current and ~~then, after reaching the final position, with a holding current, and in that then the determination of the offset error is carried out on the other coil (14, 16).~~ a holding current such that the actuator is transferred into the final position.

5. (Amended) A circuit for determining the offset error of a measurement ~~that is~~, the measurement subject to ~~such~~ an offset error of ~~the~~ a coil current I of an electromagnetic actuator~~(1) having~~, the circuit comprising:

at least one coil ~~(14, 16),~~ with a resistor ~~(R)~~ connected in series into a supply line of the coil~~(14, 16),~~;

a differential amplifier ~~(30),~~ to which the potential on both sides of the resistor ~~(R)~~ is fed~~,~~; and

a control circuit ~~(33, 34, 35),~~ which evaluates the output of the differential amplifier ~~(30)~~ when the coil ~~(14, 16)~~ is not carrying any current during the operation of the actuator~~(1)~~, and ~~takes~~ the value obtained is output as the offset error I_o.

6. (Amended) The circuit as claimed in claim 5, ~~characterized in that~~ wherein the output of the differential amplifier ~~(30)~~ is fed together with the output of a constant-voltage source ~~(32)~~ to an adding element ~~(31), with the result that there is always~~ such that an offset error ~~signal~~ of a specific polarity is obtained.

7. (Amended) The circuit as claimed in ~~one of the preceding circuit claims, characterized in that, for an actuator with two coils, respectively~~ claim 5, wherein the actuator has first and second coils assigned to a final position~~(19, 20)~~, and

a resistor ~~(R)~~ is connected in the supply line to each coil~~(14, 16)~~, ~~a~~ the differential amplifier ~~(30) respectively~~ taps the voltage dropping across ~~said~~ the resistor, and the control circuit ~~(33, 34, 35)~~ evaluates ~~both~~ outputs of the differential amplifiers~~(30)~~.

8. (Amended) The circuit as claimed in claim 7, ~~characterized in that~~ wherein the control circuit ~~(33, 34, 35)~~ for supplying current to the ~~coils (14, 16) is designed in such a way that, for transferring the actuator (1)~~ first and second coils transfers the actuator into a final position~~(19, 20)~~, and

the first coil ~~(14, 16)~~ assigned to ~~this~~ the final position ~~(19, 20) firstly~~ carries a capture current ~~(Fs, Fo) and then, after reaching the final position (19, 20), a holding current(Hs, Ho), and in that the control circuit (33, 34, 35) then~~ and a holding current, and the control circuit evaluates the output of the differential amplifier ~~(30)~~ of the ~~other~~ second coil~~(16, 14).~~.

9. (Amended) The method as claimed in ~~one of claims 1 to 4, characterized in that~~ claim 1, wherein the offset error I_o is determined and low-pass-filtered ~~several~~ multiple times.

In the Abstract:

Please replace the Abstract with the substitute Abstract attached hereto.